Acta Medica Okayama

Volume 45, *Issue* 2 1991 *Article* 2

APRIL 1991

Examination of microvascular structures of midcortical region in sheep kidneys: a three dimensional approach.

Ozkan Oguz[*] Fahri Dere[†]

Ahmet H. Yucel[‡] Behice Durgun-Yucel[**]

[*]The Cukurova University,

[†]The Cukurova University,

[‡]The Cukurova University,

[**]The Cukurova University,

Examination of microvascular structures of midcortical region in sheep kidneys: a three dimensional approach.*

Ozkan Oguz, Fahri Dere, Ahmet H. Yucel, and Behice Durgun-Yucel

Abstract

Polyester-crystic cast was observed to reach the peritubular capillary plexus following injection in sheep kidneys. Microvascular structures in this region are also reported in this study. Glomeruli were found to vary in size and shape. Diameters of afferent arterioles were larger than those of efferent arterioles. The glomerulus is supplied by more than one afferent arteriole, and in some regions, the blood in afferent arterioles joins collateral circulation via the intercapillary plexus. Morphological properties at the end of the peritubular capillary plexus were found to be remarkably significant.

KEYWORDS: vascular casts, kidney glomerulus, glomerular efferent vessels

---

*PMID: 1867114 [PubMed - indexed for MEDLINE]

Acta Med Okayama 45 (2) 77-80 (1991)

Examination of Microvascular Structures of Midcortical Region in Sheep Kidneys: A Three Dimensional Approach

Özkan Oguz*, Fahri Dere, Ahmet H. Yücel and Behice Durgun-Yücel

Department of Anatomy, School of Medicine, The Cukurova University, Balcali 01330, Adana-Turkey

Polyester-crystic cast was observed to reach the peritubular capillary plexus following injection in sheep kidneys. Microvascular structures in this region are also reported in this study. Glomeruli were found to vary in size and shape. Diameters of afferent arterioles were larger than those of efferent arterioles. The glomerulus is supplied by more than one afferent arteriole, and in some regions, the blood in afferent arterioles joins collateral circulation via the intercapillary plexus. Morphological properties at the end of the peritubular capillary plexus were found to be remarkably significant.

Key words : **vascular casts, kidney glomerulus, glomerular efferent vessels**

A number of studies concerning the microvascular organization of the kidney have been published since the discovery of the glomerulus (1-13) that provide a detailed body of data on the morphological features of these microvascular structures.

Serial section (7), microdisection (7,11), and corrosion cast methods (2,6,8,9,13,14) have provided complementary information about the microvascular organization. To date, the most accurate data on the three dimensional microvascular structures are obtained from the corrosion cast method (2). Since the 17th century, when solidified masses were injected, the method has continued to provide detailed data on the examination of the lumens of organs and vessels (2,6,8,9, 12-14). Improved injection methods and materials led to more detailed classification of the structure of the glomerulus, efferent arteriole, and the peritubular capillary plexus.

Materials and Methods

Ten sheep were used in this study (12-16 months old, 35-40 kg). Kidneys and surrounding tissues were removed one half hour following death by individual incision to the point where renal arteries arise from the abdominal aorta. Ten cc of physiological saline solution containing 2 % heparin was injected into the renal artery 10 times after separating the tissues surrounding the kidney. To demonstrate the glomular structure, 15 cc of polyester crystic (Dewilux 511-0196, Izmir/Turkey), with a characteristic viscosity was injected in the renal artery. Monoethylglycol, and a colored substance (CBS, Alpha RX Istanbul/Turkey) were used to increase the fluidity and color formation respectively.

The prepared material was introduced into the lumen vessel via injector under gradually increasing pressure.

* To whom correspondence should be addressed.

The polyester-crystic was allowed to harden *in situ* for 24 h. Then the tissue samples were put in 37% HCl for another 24 h. After tissue corrosion, the layers and acid were washed with pressured running water.

Dissection was carried out under stereomicroscope (Leitz) in gross preparations which were later examined under light microscope (Olympus BH-2) at × 10 magnification.

Results

Microscopic plastic models of microvascular formations in sheep kidneys made possible a comparative examination of structural detail of intrarenal microcirculation and microvasular for-

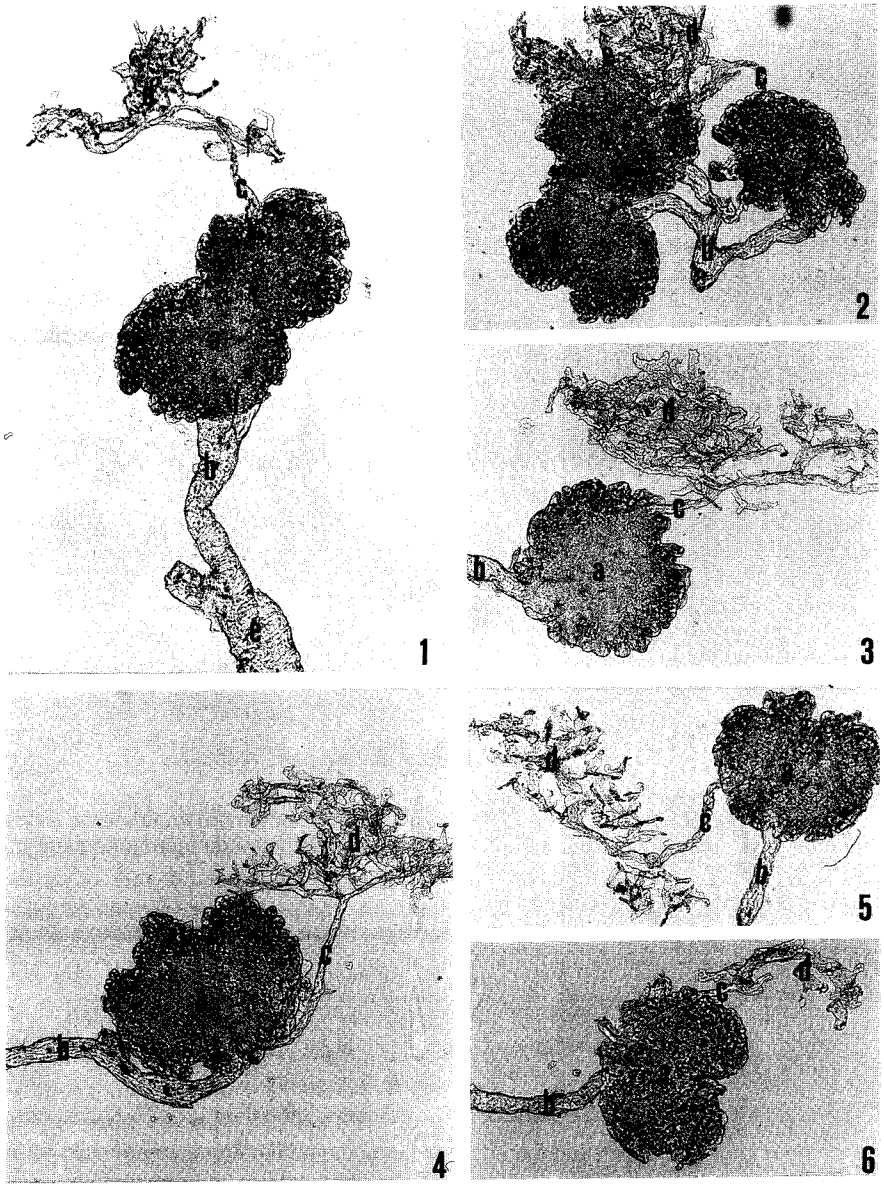

Fig. 1 Light micrograph of polyester-crystic cast of sheep kidney (midcortical region): a. Glomerulus, b. Afferent arteriol, c. Efferent arteriol, d. Peritubular capillary plexus, e. Interlobuler arteriol × 10.

mations. Natural, three-dimensional models of glomeruli were recorded in different positions in micrographs. In this investigation, we observed that affrent arterioles branched to two glomeruli (Fig. 1). A single significant, morphological difference in size was observed. Glomeruli receiving the branched afferent arterioles with larger diameters were larger than those receiving afferent arterioles of smaller diameters.

Anastomosis was observed during examination of the micrographs of the peritubular plexus (Fig. 1). The efferent arteriole, at a short distance from the vascular pole of cortical glomerulus shows many branches. Morphological structure in the terminal region was found to be more remarkable than the variation in the formation of the peritubular capillary plexus (Fig. 1).

Discussion

In a number of reported studies of renal vascular structures (2,4,5,9,14) various substances had been injected, which were subsequently revealed by tissue corrosion and thin section examination. Polyester resins have been identified as suitable material for arterial injection (14). In order to obtain detailed information about the three dimensional renal vascular structures, the polyester crystic produced by Dewilux was chosen because it is economical, available, fairly fluid, and can flow through capillaries.

Interlobular arteries branch to afferent arteriolae. A few afferent arterioles may arise from arcuate and interlobular arterioles (15). Generally, an afferent arteriole may branch to serve one, or two glomeruli.

The diameter of the afferent arteriole has been observed to be larger than the diameter of the efferent in the cortical region (4,5,15). However the influence of injection and fixation on the diameters of vascular structures could not be measured exactly (4). Variation in the diameter and length between afferent arterioles supplying the branches of more than one glomerulus is considered to be a natural formation of the regular intraglomerular microcirculation.

Different methods have been developed to make a detailed classification of the structure of efferent arterioles (2). These studies have used histological methods, and corrosion cast methods to describe efferent arterioles in various species (2). Studies on the peritubular capillary plexus that is formed by the efferent arterioles have also been done. Results of these prior studies concur with the results obtained from our sheep kidney study.

This study ended at the terminal region of the peritubular capillary plexus. A similar morphological study using sharks also ended at this region (8). Micrographs of vascular structures of sheep kidneys taken with the light microscope vary only slightly from the scanning electron micrographs of structures taken from sharks. A question remains regarding possible structures in the terminal region of the peritubular capillary plexus. Are more, undescribed structures present, or are they merely polymers, formed by the breakdown of the capillary walls ? It is perhaps too eary to draw conclusions from studies to date. However future studies should recall that the injection material imitates exactly the region it fills.

References

1. Barajas L and Latta H: A three dimentional study of the juxtaglomerular apparatus in the rat. Lab Invest (1962) **3**, 257-269.
2. Beeuwkwes R III: Efferent vascular patterns and early vasculartubular relations in the dog kidney. Am J Physiol (1971) **2**, 1361-1374.
3. Bentley MD, Hoffman EA, Fiksen-Olses MJ, Knox FG, Ritman EL, and Romero JC: Three dimentional canine renovascular structure and circulation visualized *in situ* with the dynamic spatial reconstructor. Am J Anat (1988) **181**, 77-88.
4. Black SD and Jones NF: Renal Disease, 4th Edition, Blackwell, London (1979) pp 3-28.
5. Brenner BM and Rector FC: The Kidney, Volume 1, Sounders, Canada (1981) pp 9-249.
6. Casellas D and Mimran A: A glomerular pathways in

intrarenal microvasculature of aged rats. Am J Anat (1979) **145**, 443–458.
7. Hamburger J, Crosnier J and Grünfeld JP: Nefrology, Volume l, Willy Medical, Paris (1968) pp 3–49.
8. Hentschell H: Renal blood vascular system in the Elasmobranch, raja erinacea mitchill, in relation to kidney zones. Am J Anat (1988) **183**, 130–147.
9. Horacek MJ, Earle Am and Gilmore JP: The renal microvasculature of the monkey; An anatomical investigation. J Anat (1986) **148**, 205–231.
10. Jamison RL: Micropuncture study of superficial and juxtamedullary nefron in the rat. Am J Physiol (1970) **218**, 46–55.
11. Mueller CB: The structure of the renal glomerulus. Am Heart J (1958) **55**, 304–322.
12. Spinelli FR and Wirz H: Non-existence of shunts between affrent and efferent arerioles of juxtamedullary glomeruli in dog and rat kidneys. Nephron (1972) **9**, 123–128.
13. Williams PL, Warwick R, Dyson M and Bannister L: Gray's Anatomy, 37th Edition, Churchill livingstone, London (1989) pp 1397–1413.
14. Tonmpsett DH: Anatomical Injections. Royal College of Surgeons of England (1969) pp 108–115.

Received September 6, 1990; accepted November 30, 1990.